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# **Science & Technology**

***Central Eurasia:  
Electronics & Electrical Engineering***

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# Science & Technology

## Central Eurasia: Electronics & Electrical Engineering

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14 April 1992

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**On Outlook for Using Hybrid Statistical Image Encoding Method in Broadcast TV Systems**

927K0168A Moscow *TEKHNICA KINO I TELEVIDENIYA* in Russian No 10 (418),  
Oct 91 pp 17-22

[Article by N.N. Krasilnikov, Leningrad Avionics Institute; UDC 621.397.7.037.372]

[Abstract] The relative advantages and shortcomings of analog vs. digital image transmission and conservation methods are discussed and the use of statistical encoding for considerably compressing or shortening the digital signal stream without negatively affecting the reproduced image quality is considered. In the hybrid statistical encoding method, each image line is divided into luminance sample blocks (picture elements) each of which is then subjected to orthogonal transformation. The correlation of pixel luminance makes it possible to use the differential pulse-code modulation (DKIM) method. Principal formulas of the method are derived and the procedure for determining the optimal code digit distribution among the spectral coefficient prediction error signals is considered. It is shown that the method is not critically sensitive to changes in the statistical image characteristics, making it suitable for broadcast TV systems; moreover, image encoding by blocks of samples additionally decreases the method's sensitivity to a change in the blocks' local statistics, i.e., their transient nature: the greater the number of the block, the higher the method's immunity. An analysis demonstrates that if an average of 1.5 binary units is used to transmit one picture element, conversion noise is unnoticeable. The conclusion is drawn that the use of the hybrid statistical encoding method in TV broadcast systems makes it possible to compress the digital stream by more than fivefold, which significantly exceeds the capabilities of the DPCM method. The encoding and decoding devices necessary for using the method are relatively simple and can be produced using a modern component base. Figures 5; references 2.

**On Multisystem Environment and Modern Alchemy or Something About Snell & Wilcox Company**

927K0168B Moscow *TEKHNICA KINO I TELEVIDENIYA* in Russian No 10 (418),  
Oct 91 pp 27-31

[Article by A.L. Shteynberg; UDC 621.397.132.5]

[Abstract] Unique studio TV and transcoding equipment which is shown by the Snell & Wilcox Company at international exhibits and is already used in the USSR is discussed from the viewpoint of today's multisystem, multiformat, and multistandard environment in all spheres of life—medicine, aviation, mechanical engineering, education, culture, etc. The specific applications of Snell & Wilcox transcoders which make it possible to interface systems using various versions of the SECAM, PAL, and NTCS standards as well as VHS and Beta

video recordings are illustrated. It is stressed that Snell & Wilcox Company products are exported to 90 countries while company revenues double annually. Today, the Aviteks firm in Moscow is a sole agent for shipping, servicing, and renting Snell & Wilcox products in the USSR. It is expected that the Snell & Wilcox Company will open an office in Moscow soon. Figures 3.

**Soviet Telecommunications: Are They Infantile for Objective or Subjective Reasons? Review of Proceedings of 'Svyaz-91', 'Intervideo-91', 'Ekspokon-91', and 'Sistemotronika-91'**

927K0167A Moscow *TEKHNICA KINO I TELEVIDENIYA* in Russian No 9 (417),  
Sep 91 pp 3-13

[Article by A.P. Barsukov; UDC 654.172(47+57)]

[Abstract] The integration of Soviet telecommunications into the world system is reviewed in discussions with industry managers. USSR Minister of Telecommunications G.G. Kudryavtsev and Chairman of the Telekom Concern E.K. Pervyshin discuss telecommunications in the USSR from the viewpoint of the organizations attempting to lead the development of the industry; the high level of telecommunications concentration in the world is addressed and some large telecommunications systems, e.g., Intelsat, Regional Sat, Inmarsat, etc., are considered in detail. Today's philosophy of telecommunications companies is examined using the example of the France Telecom Association. The outlook for receiving satellite TV on territory of "1/6 of the planet [Former Soviet Union]" is investigated. A review of various management philosophies and concepts culminates in the conclusion that the only way to maximize the incentives for telecommunications development in the USSR and for bringing it to today's level is to make the activity of the Telecommunications Ministry, television, defense, and space industry leaders and managers accountable to the public and hold them personally responsible for their actions, even resorting to radical measures. The author is grateful to the "Ekspotsentr" for help. Tables 5.

**Analyzing Spatial Information by Movable TV Camera**

927K0167B Moscow *TEKHNICA KINO I TELEVIDENIYA* in Russian No 9 (417),  
Sep 91 pp 27-29

[Article by O.L. Volkov, Leningrad Telecommunications Institute imeni M.A. Bonch-Bruyevich; UDC 621.397.424]

[Abstract] The difficulty of rendering the depth of field in projecting three-dimensional images onto a two-dimensional television screen and various methods of forming three-dimensional images are discussed and a procedure for determining the spatial parameters of randomly moving objects as well as their characteristics

of motion based on continuously tracking a point selected by the TV camera operator on the boundary of the object is considered. In this method the TV camera travel perpendicular to its optical axis by a distance equal to the stereoscopic filming baseline is assumed to be known. It is also assumed that during the time between two adjacent frames, the movement of the point on the image is insignificant. The proposed moving camera TV system is analyzed by computer simulation at the Leningrad Telecommunications Institute imeni M.A. Bonch-Bruyevich (LEIS); the results show that a measurement error appears due to the photoelectric converter's persistence and may reach a high value. The use of digital TV systems with a 13 MHz sampling rate and a focal length and baseline of over 10 cm, given a camera distance from the object of over 5 m, makes it possible to lower the error to single percentage points or less while a 50 MHz sampling rate ensures the best results in measuring the motion coordinates. Figures 2; references 5: 3 Russian, 2 Western.

#### **Economics of Regulation Luminous Flux from Discharge Lamps in Outdoor Lighting Systems**

927K0153A Moscow SVETOTEKHNIKA in Russian  
No 11, Nov 91 pp 10-13

[Article by Y.Yu. Martinaytis, candidate of technical sciences, I.K. Nagovskiy, engineer, and A.K.-Y. Yasin-skis, Kaunas Technical University and "Lensvet" Electrical Network Enterprise; UDC 628.93.003]

[Abstract] The operation of discharge lamps in outdoor lighting systems is analyzed with regard to economy of energy consumption and life expectancy, regulation of the luminous flux being considered as a way improve both and thus satisfy the governing Construction Norms and Rules. Data on outdoor lighting systems with DRL mercury-vapor lamps and DNaT sodium-vapor lamps in 50 cities reveal that about 70 percent of all these lamps in these systems operate on the average at 230 V or 4.55 percent above their nominal voltage, while the latest specifications allow a 10 percent voltage rise so that electric power drawn by these lamps can increase by 20 percent (DRL) or 27-30 percent (DNaT). This and excessive variation of ballast choke parameters are the two basic causes of lamp failure, poor lamp quality being the third cause. A device regulating the luminous flux over the 50-100 percent range by regulating the discharge voltage over the 50-100 percent range without distorting its sinusoidal waveform, nor distorting the current waveform and decreasing the power factor of the lighting unit, has been developed at the Kaunas Technical University for protection of high-pressure mercury-vapor and sodium-vapor lamps. This regulator includes a set of switches and a 3-phase 380/220 V - 50 Hz autotransformer which draws only 15-20 percent of the load power. The bank of lamps forms a balanced 3-phase load, all connected on one side to the common neutral conductor. On the other side each sodium-vapor lamp is

in series with a standard 1-phase starter-reactor connected to one of the line conductors and each mercury-vapor lamp is in series with a starter-reactor connected across two line conductors. A comparative evaluation of such a lighting system with discrete regulation of the luminous flux and a standard one indicates that use of 40 kVA TARN regulator costing about 5000 rubles will save at least 20 percent electric energy for the same luminous output, extend the life of DRL lamps (now 8000 h) and DNaT lamps (now 5000 h) by 30 percent, while increasing the cost effectiveness of DNaT250/400 lamps by 17 rubles/kVA and the cost effectiveness of DRL250/400 lamps (higher fixed cost) by 8.5 rubles/kVA. Figures 3; tables 2; references 12.

#### **Twenty-Second Congress of International Commission on Illumination**

927K0153B SVETOTEKHNIKA in Russian  
No 11, Nov 91 p 27

[Article by Yu.I. Sviridov, engineer, and O.S. Filatov, candidate of technical sciences, All-Union Scientific Research Institute of Illumination Engineering; UDC 628.9:06.055]

[Abstract] The 22-nd CIE Congress in Melbourne (Australia) on 1-12 July 1991 dealt essentially with administrative problems such as collaboration with the IEC and the ISO. Financial matters and membership were discussed at sessions of the Administrative Council. With one country (Romania) having joined and three countries (Mexico, Pakistan, Peru) having been ousted for nonpayment of dues, the Commission now seats 35 national committees and 10 individual members. Technical matters and publications were discussed at sessions of the Executive Council, in response to reports given by the president, the secretary, and the vice-presidents of the CIE. A new Administrative Council was elected to include: R.K. Oldworth of the U.K. as president, H.A. Lefberg of Sweden as vice-president for technical matters, W.G. Julian of Australia as vice-president for publications, G.R. Shakhparuyants of the USSR, G.I. Kaufman of the U.S., and K. Narisada of Japan as vice-presidents, G. Bastie of France as secretary, and K. Scott of the U.K. as treasurer. The 3-day conference on illumination covered reports by individuals on lighting of outer space, color transmission, lighting of communal and residential buildings, development of a worldwide illumination engineering base, and illumination engineering education, also a proposal by the Soviet national committee to establish two new technical committees on luminous printing and on slit optical fibers respectively. An exhibition "Illuminex-91" had been arranged for this conference by over 30 lighting equipment manufacturers. At the conference of CIE Departments were elected new directors: F. Ikeda of Japan for Department 1, I.F. Handsberger of South Africa for Department 2, P. Chauvel of France for Department 3, R.W. Holmes of

the U.K. for Department 4, V. van Bommel of Netherlands for Department 5, D.H. Sliney of the U.S. for Department 6, and M. Seidl of Germany for Department 7.

#### **Conceptual Lighting System Proposals for Moscow**

927K0116A Moscow SVETOTEKHNIKA in Russian  
No 8, Aug 91 pp 16-19

[Article by N.I. Shchepetkov, candidate of technical sciences, Moscow Institute of Architecture; UDC 628.974(47+57-25)]

[Abstract] Six conceptual variants of a new street lighting system for the city of Moscow proposed which will satisfy aesthetic as well as ecological and economic criteria in compliance with the General Plan originally devised and subsequently revised at the Scientific Research and Planning Institute for Moscow. The description of each is aided by a diagram representing the city layout schematically: a circular central hub area surrounded by four successively wider belts with a circular artery around each, and a "star" of six straight radial arteries 60° running from the central hub through all four belts to the periphery. Each variant represents a different pattern of lighting level gradation: 1) asteroidal, 2) central, 3) zonal, 4) arterial, 5) based on districting criteria, 6) based on landscaping criteria. They are also different in terms of lighting quality gradation and light color allocation pattern. Seven colors of light are to be available: sun white, cold white, bluish white, golden white, golden yellow, pale blue, and greenish blue. Figures 6; references 6.

#### **Prospects of Introducing Chemical Nickel Plating Process for Illumination Engineering Equipment**

927K0116B Moscow SVETOTEKHNIKA in Russian  
No 8, Aug 91 pp 19-20

[Article by T.G. Aryanina, candidate of technical sciences, Ye.V. Makarova, engineer, and S.A. Muravyeva, engineer, All-Union Institute of Illumination Engineering imeni S.I. Vavilov; UDC 628.94.002.546.74]

[Abstract] Protective and decorative nickel plating of lighting equipment by an electroless chemical process is proposed, namely by the Brenner-Riedel process of nickel recovery from aqueous solution of its salt and sodium hypophosphate as reducing agent. Such a coating will contain 4-10 percent phosphorus. This increases its hardness, especially after heat treatment at 400°C for 1 h, and increases its wear resistance up to that of a chromium coating. Such a nickel coating is, moreover, much tighter and corrosion-resistant than an electrolytically deposited one, an 8 percent or higher phosphorous content making such a coating solderable. A drawback are the more stringent technological requirements, namely: precise control of composition and pH within narrow ranges, thermostatic control within the relatively high 78-95°C temperature range, and a very reliable extrusion system. The process was applied to parts made of rimmed grade-08 carbon steel, subsequent corrosion tests having yielded satisfactory results. The process is also applicable to aluminum, copper, and brass surfaces, glass, ceramic, and plastic surfaces, but a chemical nickel coating will not form on cadmium, tin, antimony, and bismuth. The process is most cost effective when applied to intricate parts and small parts such as pins, also where carbon steel is to replace stainless steel for cost reduction. Tables 1; references 9.

**Soviet High-Definition Television**

927K0165A Moscow *RADIOTEKHNIKA*  
No 9, Sep 91 pp 7-8

[Article by L.M. Gribov; UDC 621.397]

[Abstract] Development of HDTV in the USSR had already begun in the 1950s, a black-and-white system for the 1125/50/2:1 standard format was devised in 1957 by A.B. Polonskiy and associates at the Moscow Television Laboratory branch of the Moscow Television Scientific Research Institute. In the 1960s T.A. Gaukhman and associates in that laboratory devised a high-definition projection apparatus using the special-purpose FREZA kinescope with mirror and lens optics. Various devices for training systems were also devised during that period, among them: display simulators (K.P. Vasilyev), a high-resolution telediagnostic tester operating in real time (B.A. Sedov), and the first-generation of information display equipment for space flight control (L.M. Gribov). In the 1970s P.N. Gisin and associates devised a high-definition apparatus including camera and video monitor for color television for the same 1125/50/2:1 standard format and currently high-resolution color television systems are being developed for various other standard formats as well. As of now Soviet television lags far behind the worldwide state of the art, owing to inadequate funding and long isolation from foreign resources. The advice to the new generation of television specialists taking over from older colleagues is: do not copy foreign research and do not follow the lead of foreign companies, thus always remaining behind, but blaze new trails.

**Development, Construction, and Experimental Design Validation of Large-Screen Television Projection Systems**

927K0165B Moscow *RADIOTEKHNIKA* in Russian  
No 9, Sep 91 pp 23-29

[Article by D.D. Sudravskiy, A.I. Shabunin, and L.N. Shvernik]

[Abstract] Design and performance data on large-screen color television projection systems for public entertainment are analyzed and evaluated, six such systems being described: 1) with a 30 m<sup>2</sup> reflection-type television screen installed in the Luzhniki Sports Palace (1972), 2) with a 70 m<sup>2</sup> reflection-type television screen installed in the Golitsyn-Pond Central Recreation Park imeni Gorkiy on an island-float for viewing a performance of "Swan Lake" by the "Volshebnyy Mir Baleta" (Volsheb World of Ballet) group during the International Youth and Student Festival (1985), 3) with a 160 m<sup>2</sup> transmission-type television screen installed in the Kremlin Convention Hall (1989), 4) with a 100 m<sup>2</sup> reflection-type television screen installed on Red Square for celebration of Moscow Day (1987), 5) with a 50 m<sup>2</sup> perforated DP reflection-type television screen installed in the Lenin-grad Concert and Sport Complex (1989), 6) with a 240 m<sup>2</sup> reflection-type television screen installed in Delhi/

India (1989). The basic equipment in these systems includes 6LK... red-green-blue kinescopes with Schmidt mirror-lens optics and electron-optical light modulators with transparent deformable active substances (synthetic detergents), all developed by the Radio Scientific Research Institute at the USSR Ministry of Communications. The development work began in 1956 under the direction of S.V. Novakovskiy and continues to completion under the direction of L.N. Shvernik, aided by D.D. Sudravskiy, A.I. Shabunin, L.A. Postnikova, and Ye. Kachurovskaya. Tables 7.

**Development and Production of Photoelectric Television Devices in USSR**

927K0165C Moscow *RADIOTEKHNIKA* in Russian  
No 9, Sep 91 pp 30-35

[Article by R.M. Stepanov; UDC 621.385.832:621.397]

[Abstract] The history of television development worldwide after discovery of the photoelectric effect is reviewed, beginning with B.L. Rosing's seminal invention of an optomechanical image scanner on the transmitter side and an optoelectronic picture tube (kinescope) on the receiver side in 1907. The review covers subsequent theoretical and practical research activity up to the present time, not only in tsarist Russia and then in the Soviet Union but also in the United States and in some other countries. As major noteworthy inventions made during that long period are mentioned the iconoscope, the orthicon, superorthicons (isocons), the vidicon, disectors, and more recently photosensitive charge-transfer devices of either linear or matrix version. This review is followed by one of current activities pertaining to modern photoelectric television components. Soviet production of 26 mm and 18 mm diameter plumbicons for studio television cameras and for facsimile news reporting systems is expected to reach 300 annually within the 1991-92 period. Disectors are now being designed and built for 100,000 h operation and 20 years life, while 25-150 mm diameter photomultipliers featuring high speed (0.3 ns), high stability (within 1 percent), and high energy resolution are already on the market. Soviet industry is planning development and production of photosensitive charge-transfer matrices containing 2x10<sup>6</sup> elements for television cameras, with prevention of signal blurring and optional electronic exposure control. Figures 6; references 6.

**Development of Video Recording in USSR**

927K0165D Moscow *RADIOTEKHNIKA* in Russian  
No 9, Sep 91 pp 42-47

[Article by A.V. Goncharov, L.G. Lishin, A.S. Mirtumov, and V.I. Parkhomenko]

[Abstract] Development of the video recording technology in the USSR is reviewed historically, beginning with the first announcement about it in "SOVETSKAYA ROSSIYA" on 20 February 1960. This

development is traced through the 1960s and subsequent decades up to the present time, the review concluding with the latest trends in this technology including production of equipment compatible with high-definition television formats for industrial and professional use as well as home entertainment.

### Use of Fast Fourier Transform in Synthesis of Programmable Digital Demodulators

927K0165E Moscow RADIOTEKHNIKA in Russian  
No 9, Sep 91 pp 63-65

[Article by V.A. Vargauzin; UDC 621.391.2:621.396.677]

[Abstract] Synthesis of a programmable digital demodulators of multipositionally frequency-shift keyed simple signals and discretely frequency-shift keyed compound signals is considered, referring to the basic algorithm of operation of a plain digital demodulator designed for optimum noncoherent discrimination of the strongest of input signals simultaneously arriving in the presence of a Gaussian noise. Use of the fast Fourier transform rather in lieu of the J-point discrete Fourier transform ( $J = T/\Delta t$ ,  $T$  - duration of signal,  $\Delta t$  - signal discretization interval) is shown to involve fewer multiplications and, therefore, to be much more economical. This advantage is especially appreciable in synthesis of demodulators of signals with a high alphabetic content. References 3.

### Metal-Dielectric Antenna Radomes

927K0165F Moscow RADIOTEKHNIKA in Russian  
No 9, Sep 91 pp 80-83

[Article by I.P. Solovyanova and M.P. Naymushin; UDC 621.396.67]

[Abstract] The problem of constructing metal-dielectric antenna radomes is analyzed, such radomes being mechanically stronger than plain dielectric ones and not less transparent to radio waves within a given frequency band. A radome in the form of an ogival shell of revolution is considered, its nose made of solid metal usually without perforation and its skirt made of a dielectric layer covering a perforated metal screen. The metal screen is regarded as an originally flat two-dimensional periodic diffraction grating with resonance holes of arbitrary shape at the nodes of parallelogrammic cells (horizontal length  $B$ , vertical height, acute base angle  $\beta$ ), bent with minimum distortion to fit under the curved surface of the dielectric layer. An algorithm is proposed for calculating the coordinates of the centers of the screen holes. It is based on a given equation  $y = f(x)$  of the radome generatrix, considering that the length  $L(x)$  of the generatrix up to any abscissa  $x$  on the radome axis is equal to the standard length-of-arc integral from 0 to  $x$  and that the radome segment integral to radio waves extends from  $x_{\min}$  to  $x_{\max}$ . The perforation pattern is then designed with the aid of tabulated  $L(x)$  values and an interpolation process. The number holes around a

horizontal circumference is calculated according to a certain formula, with appropriate correction of the circumferential perforation period  $B'$ . The number of holes along the generatrix must ensure a "vertical" perforation without overlapping of adjacent circles and the cell height  $A$  must, therefore, be not smaller than the largest hole dimension plus the maximum web width permissible according to this criterion. The algorithm allows for ample use of experimental data in the design and performance analysis of such a radome. Several ogival radomes for centimeter-wave radio antennas were built on the basis of this design algorithm and tested, their length ranging from  $8\gamma$  to  $9\gamma$  ( $\gamma$  - signal wavelength) and the declination of their generatrix from their vertical axis ranging from  $30^\circ$  to  $8^\circ$ . The nose of each was a metal hemisphere with a radius  $R = 0.4\gamma$ . Some had the skirt made of thin metal foil and some had it made of 2 mm thick metal sheet, each coated with a 3 mm thick layer of glass-textolite (dielectric constant  $\epsilon = 7$ ). Each radome was, for testing, placed over the platform of a phase-lock direction finder carrying a set of almost nondirectional helical antennas. The tests were performed in an anechoic chamber, with the field of the transmitter horn antenna polarized in either of two orthogonal directions. The results of these tests the proposed design method. Figures 3; references 2.

### Ratio of Two-Level Signal to Noise in Receiver Side of Fiber-Optic Communication System

927K0165G Moscow RADIOTEKHNIKA in Russian  
No 9, Sep 91 pp 86-89

[Article by A.N. Dorofeyev; UDC 621.391.64]

[Abstract] The signal-to-noise ratio in a receiver of binary signals in a digital fiber-optic communication system is evaluated, this parameter being a basic design parameter for such a system. It is a current ratio, inasmuch as the detector on the receiver side converts input power into output current. The expression for this ratio  $\psi = mS/D_1^{1/2}$  ( $S$  - signal current,  $D_1^{1/2}$  - dispersion of noise in incoming message) differs from the conventional one by the factor  $m = (S-T)/S$  ( $T$  - optimum threshold reception level relative to actual signal level). Although the quantum noise is associated with a incidence of a signal and is generally not additive, it may be regarded as an additive one independent of the signal when the latter maintains a constant level and arrives without multiplicative interference. A mixture of an optical signal and a noise is treated as a time-dependent continuous random process with varying message and pause levels, their mixture at the receiver gate thus being best represented by corresponding two random sequences with quantum noise present only during message time and not during pause time. The mean value and the dispersion of each sequence are measurable, by extremum-inclusive sampled-data averaging. On the basis of this model is obtained an expression for the maximum attainable signal-to-noise ratio in the receiver of such a communication system. References 7.



### Communication System With Single-Sideband Frequency Modulation

927K0121A Moscow *RADIOTEKHNIKA* in Russian  
No 8, Aug 91 pp 6-9

[Article by M.M. Shakhmayev; UDC 621.376.326]

[Abstract] A new communication system with single-sideband frequency modulation is proposed as a way to ensure not only the same high interference immunity and absence of nonlinear signal distortions characterizing conventional FM systems but also to avoid crowding and thus overloading the signal carrying medium, considering that both the signal-to-noise ratio and the bandwidth of an FM radio line are proportional to the modulation index. While in known single-sideband FM systems the modulation index is limited to  $\beta < 1$  rad (U.S. Patent No 3,868,599) so as to avoid excessive buildup of voltage and power peaks owing to attendant exponential amplitude modulation and is limited to  $\beta \leq 0.25$  rad (Japanese Patent No 32,284) so as to avoid buildup of nonlinear distortions, the proposed system (USSR Patent No 1,566,494) can operate with an arbitrarily large modulation index,  $\beta \leq 1.57$  rad and  $\beta > 1.57$  rad. This is demonstrated by an analysis of its energy characteristics. The receiver includes a high-frequency input amplifier, two filters extracting the carrier and the modulation signal respectively, five signal-by-signal multiplying devices, two low-pass filters, three equalizing amplifiers, a subtracting device, a square-root evolving device, a summing device, a high-frequency 90° phase shifter, and a frequency detector. It must also include a differentiating device, two amplitude limiters, a sign assigning device, a band-pass filter extracting the sign-of-derivative signal, and a sign-of-derivative detector. The transmitter of single-sideband FM signals with a modulation index  $\beta \leq 1.57$  rad consists of a phase shifter, two self-excited oscillators, a modulation signal generator, a phase modulator, two signal-by-signal multiplying devices, two low-pass filters and one band-pass filter, a summing device, filter, and a normalizing amplifier. For single-sideband signals with a modulation index  $\beta > 1.57$  rad, the transmitter must also include formation and extraction of the sign-of-derivative signal. Figures 5; references 6.

### Properties of Feedback Element for Linear Microwave Transistor Amplifiers

927K0121B Moscow *RADIOTEKHNIKA* in Russian  
No 8, Aug 91 pp 10-14

[Article by V.Ye. Safronov; UDC 621.375.029.64]

[Abstract] Insertion of a capacitive microstrip line with a flat over the 1-10 GHz range amplitude-frequency characteristic and with an impedance dependent on the degree of topological manufacturing inaccuracy into the resistive feedback loop of a linear microwave transistor amplifier, as a way to decrease the phase lead and prevent destabilization of such an amplifier. This is preferable to compound reactive matching with negative feedback, a likely

cause of oscillation and less sensitive to parameter variations. A theoretical circuit and performance analysis, supported by experimental data, indicates that the amplitude-frequency characteristic of the amplifier will not be additionally distorted by such a capacitive element in the resistive feedback loop and its impedance as well as the feedback factor will be sensitive to deviations from nominal values of circuit parameters. Such a feedback can, therefore, be designed to simultaneously compensate manufacturing inaccuracy and variations due to temperature changes. Figures 2; references 5.

### Change in Parameters of Low-Noise Amplifier Caused by Strong Interference Pulses

927K0121C Moscow *RADIOTEKHNIKA* in Russian  
No 8, Aug 91 pp 18-20

[Article by V.V. Antipin, V.A. Godovitsyn, D.V. Gromov, A.O. Kozhevnikov, and A.A. Ravayev; UDC 621.375.029.64]

[Abstract] An experimental study of SchFET (field-effect transistor with Schottky gate) low-noise amplifiers was made concerning the effect of interference pulses on their performance, considering the possibility of either reversible or irreversible failure depending on the input power. Tests were performed on a hybrid-circuit 1.5 GHz amplifier with a 10 dB gain, 1.5 dB noise factor, and a voltage standing-wave ratio  $VSWR \leq 3$ , its transistor having a 280  $\mu\text{m}$  wide and 1  $\mu\text{m}$  long Schottky gate formed on an about 0.2  $\mu\text{m}$  thick GaAs with an electron concentration of the order of  $10^{17} \text{ cm}^{-3}$ . To the input of this amplifier were applied pulses of 0.1-2  $\mu\text{s}$  duration with a 9.4 GHz microwave content, their power being varied over the 20-140 W range. An analysis of the results based on the Wunsch-Bell-Taska model and diagnostic examination under a microscope indicates different mechanisms of amplifier performance degradation depending on the input power. Degradation upon incidence of a low-power pulse is evidently caused by impedance mismatch between the transistor and the passive circuit stages. Degradation upon incidence of a high-power pulse is evidently caused by long-lasting effects. The curability of these effects is determined by the relaxation of electrons following their capture by deep energy-level traps at the channel-substrate interface. They become catastrophic when the input power is very high, because of heating above the stability limit for inhomogeneities within the transistor structure and subsequent structural breakdown of the transistor. Figures 4; tables 1; references 8.

### Millimeter-Wave Antenna With Holographic Control Using Fiber Optics

927K0121D Moscow *RADIOTEKHNIKA* in Russian  
No 8, Aug 91 pp 42-44

[Article by A.S. Afrimeyev, V.A. Kaplun, and I.A. Naumov; UDC 621.396.677:681.883.752]

[Abstract] Holographic control of phased millimeter-wave antenna arrays using fiber optics (N.H. Farhat; IEEE TRANSACTIONS: ANTENNAS AND PROPAGATION Vol 28 No 4, 1980) is evaluated, considering that such a control system is simpler and less costly than conventional ones for microwave antennas. Formation of desired radiation patterns by means of a diapositive or a holographic lens is demonstrated for a horn antenna of a microwave transmitter. The apparatus includes a slide or lens illuminator, a dielectric waveguide and a reflection grating behind it at some given distance, a light absorber, and an optical fiber carrying a set of piezoelectric transducers. The diapositive carries the same information as does a conventional one, interference of the controlled primary beam and the reference beam having resulted in appropriate spatial amplitude modulation. A drawback of an amplitude-modulated diapositive is that it forms two other beams in addition to the useful one, namely its conjugate and a zeroth-order beam not subject to control. One can reconstruct the original wavefront and shape a microwave beam by illuminating the diapositive. Most desirable is holographic reconstruction which channels all the microwave power into one beam, which a phase-modulated rather than amplitude-modulated diapositive will do when several dielectric waveguides are placed in a row behind the hologram (their number corresponding to the necessary points on the raster). Any desirable antenna radiation pattern, symmetric or asymmetric, can be synthesized by appropriate selection of amplitude and phase distributions in the original beam. With the aid of a holographic diapositive, moreover, the microwave beam to be reconstructed can be altered fast by way of scanning, focusing, defocusing, or otherwise. Various semiconductor materials have been tested for dependence of their reflection coefficient on the modulation factor and frequency of the illuminating wave beam. Silicon was found to be the best, owing to its fast response and to the almost linear dependence of its transmission coefficient on the intensity of incident excitation. Figures 1; references 2.

#### Scattering of Radio Waves by Terrain Inhomogeneities along Ground Surface Channel

927K0121E Moscow *RADIOTEKHNIKA* in Russian  
No 8, Aug 91 pp 44-46

[Article by A.A. Fomin; UDC 621.371]

[Abstract] Scattering of radio waves by natural or artificial inhomogeneities of the terrain is analyzed theoretically in the quasi-local approximation, assuming a flat ground surface. The problem is solved by an asymptotic rather than numerical method in the geometrical-optics approximation, because of limited computer capacity, terrain inhomogeneities being accounted for by local Fresnel coefficients and the scattered electric field being represented by a two-dimensional Fourier series. The analysis is demonstrated on a single inhomogeneity at some point between the transmitter antenna and the receiver antenna but not necessarily on the line joining

them. The normalized radiation pattern of the transmitter antenna as well the height of each antenna being given. The electric field at the reception point is the resultant of three: that of the wave arriving directly from the transmitter over the air and two arriving from the inhomogeneity, one specularly reflected and one scattered by it. A water reservoir is considered as an example of a terrain inhomogeneity, approximately triangular in the plane view, situated off the straight transmitter-to-receiver path and the form of its scattering pattern determined by its electrical dimension  $kd = 24$ . Figures 2; references 5.

#### High-Power Multimode Y Circulator

927K0121F *RADIOTEKHNIKA* in Russian  
No 8, Aug 91 pp 46-48

[Article by A.V. Sloushch and I.G. Neklepayev; UDC 621.372.832.8]

[Abstract] The feasibility of operating a multimode Y circulator at high power levels in the microwave range is examined, such a circulator consisting of three rectangular waveguides  $12.6 \times 28.5 \text{ mm}^2$  in cross-section having been tested in the 3 cm wave band. Its structure differed somewhat from that of known ones (U.S. Patent No 4,638,267; W. Holpp and S. Bartels; *MIKROWELLEN MAGAZIN*, in German Vol 11 No 1, 1985), the half-wavelength high ferrite post between dielectric (teflon) shims having been replaced with two quarter-wavelength high ones on the splitter walls. Ferrite posts and composite ferrite-dielectric posts were tested, using Polikor as the dielectric material and five different normalized grades of ferrite (3Sch15, 8Sch5, 10Sch6, 30Sch3, 50Sch1). The dimensions of the ferrite post for each circulator variant were selected so as to keep the relative saturation magnetization  $p_s = \gamma M_s / f_0$  within the 0.16-0.8 range ( $M_s$  - saturation magnetization,  $\gamma$  - gyromagnetic ratio,  $f_0$  - center frequency of operating range). Each variant was tested for the dependence of the insertion loss on the power of incident pulses, the critical level of input power corresponding to a 0.1 dB increase of the insertion loss. The results indicate that it is possible to attain of critical power levels up to and above 300 W with low- $p_s$  ferrite posts weak magnetizing fields where  $\sigma = \gamma H^1 / f_0 < 0.5$  ( $H^1$  - intrinsic intensity of magnetizing field). The circulators with 30Sch15 and 10Sch6 ferrite were also tested for thermal stability, these two materials being most promising on account of the lowest insertion loss and the lowest temperature rise under a high average input power. Figures 2; references 9.

#### Effect of Refraction on Structure of Radar Signals Reflected by Sea Surface

927K0115A Moscow *RADIOTEKHNIKA* I  
*ELEKTRONIKA* in Russian Vol 36 No 7,  
Jul 91 pp 1233-1237

[Article by A.V. Volkov, K.V. Koshel, K.V. Latyshev, L.A. Slavutskiy, B.M. Shevtsov, and A.A. Shishkarev; UDC 621.396.96]

[Abstract] The spatial structure of radar signals reflected by a rough sea surface is analyzed for the effect of refraction. The analysis is based on measurements made during the summer 1989 voyage of the "Academician A. Nesmeyanov" scientific research vessel carrying an "Okean M-03" navigator station. This station containing two circular-sweep radar sets operating at 3 cm and 10 cm wavelengths respectively, their receiver-transmitter antennas having been mounted 25-26 m above sea level so as to extend their horizon to about 20 km radius. A calibrated microwave receiver, with a horn antenna mounted 7 m above sea level, served as a monitor. The envelopes of radar echo signals were picked up by an analog magnetic sound recorder with a frequency range up to 5 MHz and from here fed to a computer either directly or through an analog-to-digital converter which encoded them at a rate of 20 MHz. The altitudinal atmospheric temperature profile  $T(z)$  and humidity profile  $e(z)$  up to 25 m above sea level were at meanwhile measured by the contact method with a radiosonde, for a determination of the refractive index  $n = (77.6/T)(p + 4810e/T)$  ( $p$  - atmospheric pressure, mbar). The close agreement of these experimental data with the results of theoretical calculations for a two-frequency radar model indicates that variations in the spatial structure of radar echo signals scattered by a sea surface are directly related to the radio-wave attenuation function (V.A. Fok, "Problems of Diffraction and Propagation of Electromagnetic Waves", Izd. Sovetskoye Radio, 1970). Refraction, accordingly, is found to exert an overriding influence on the magnitude of radar echo signals returning from behind the horizon and especially the magnitude of the shorter-wave (3 cm) ones. Figures 5; references 15.

#### Amplitude-Phase Fluctuations of Millimeter Radio Waves in Turbulent Atmospheric Ground Layer

927K0115B Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 7, Jul 91 pp 1247-1254*

[Article by A.S. Zakharov and V.A. Timofeyev; UDC 621.371:551]

[Abstract] Amplitude-phase fluctuations of millimeter radio waves in a turbulent boundary layer such as the atmospheric ground layer are analyzed theoretically in the approximation of smooth perturbations, assuming that the distribution of the complex field amplitude in the antenna exit aperture represents a collimated single-mode Gaussian beam with a radius equal to the radius of an equivalent beam with a uniform distribution of the field amplitude in the exit aperture of a correspondingly equivalent antenna. The distribution of the refractive index is assumed to be statistically uniform and isotropic, its fluctuations being delta-correlated in the direction of wave propagation. The latter assumption simplifies the problem, but is valid only for atmospheric ground layers passing over slightly rugged terrain of one kind. Calculations made on a BESM-6 high-speed computer, using amplitude and phase functions correlated in

both space and time in accordance with the hypothesis of "frozen in" turbulence, reveal the dependence of the normalized dispersion of those fluctuations on the wave parameter  $P = x/k\rho^2$  ( $k = 2\pi/\lambda$ ,  $\lambda$  - wavelength,  $\rho$  - magnitude of radius-vector in a plane perpendicular to the direction of wave propagation,  $x$  - distance from the antenna exit aperture,  $x = L$  distance from that aperture to the reception point;  $P^* = 1$  for a plane wave,  $P^* = > 1$  for a spherical wave) and on the turbulence parameter  $k_0 = 2\pi/L_0$  ( $L_0$  - external scale of turbulence) or  $k_0^* = (2\pi\lambda L_0)^{-1/2}/L_0$ . The dispersion of amplitude-phase fluctuations in a collimated beam of millimeter radio waves is found to be minimum where the height of the Fresnel zone is  $(\lambda L)^{1/2} L_0$ . The results are comparable with the authors' experimental data pertaining to propagation of 8.2 mm radio waves over a 4 km long route. The authors thank M.N. Zakharov and A.S. Aleksandrov for performing the computer-aided calculations and for assisting in the experiments. Figures 4; references 10.

#### Numerical Modeling of Phased Array of Asymmetric Log-Periodic Antennas

927K0115C Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 7, Jul 91 pp 1267-1271*

[Article by V.A. Strizhkov; UDC 621.396.67.01]

[Abstract] A mathematical model of a phased array consisting of asymmetric log-periodic antennas with  $\Pi$ -form vertical wire dipoles is constructed, the advantages for such antennas being not only absence of cophasal waves in the exciter channel but also simplicity of their design. The model is based on numerical solution of the Pocklington integral equation by the method of moments, using piecewise-trigonometric basis and weight functions so as to ensure a uniform stability of the solution. Inasmuch as a correct description of one such antenna requires approximately 200 basis functions and thus a fast formation of the mutual-impedance matrix followed by solution of a highly multidimensional system of linear algebraic equations, a simpler procedure is proposed which utilizes the regularity of such phased antenna arrays and three properties of their mutual-impedance matrix. These are: 1) partitioned form of this matrix, 2) coupling of arbitrarily located semidipoles, 3) singularity of the integrand function referring to adjacent semidipoles. The procedure and its convergence are validated by a theorem which is readily proved. Convergence is assured for any sufficiently small values of the "ka" parameter with any choice of the initial approximation and for any magnitude of current  $I_k^0$ , but the speed of convergence depends largely on the initial approximation. The procedure is demonstrated on numerical evaluation of the traveling-wave ratio at frequencies covering the entire bandwidth, for a single log-periodic antenna as well as for the central one and an outermost one in a phased array. Two such arrays are furthermore considered consisting of eight and of four antennas respectively. The width of their radiation patterns at frequencies covering the same range have been

evaluated numerically and are compared with those obtained by measurement. The author thanks A.S. Ilinskiy for discussion and valuable suggestions, also N.S. Shvedov and Yu.A. Larin for supplying experimental data. Figures 3; references 9.

#### **Small Solid-State Microwave Oscillator**

927K0115E Moscow *RADIOTEKHNICA I  
ELEKTRONIKA in Russian Vol 36 No 7,  
Jul 91 pp 1398-1401*

[Article by I.A. Astionenko and A.P. Motornenko; UDC  
621.372.852:621.373.2]

[Abstract] A new type of solid-state microwave oscillators is described which combines small size and small weight with high power rating. Their main feature is a high-Q resonator for beyond-cutoff modes, a cruciform H-plane splitter of identical rectangular waveguides for  $H_{p90}$  - modes with a square insert-bar of a solid dielectric material filling the entire crossover space. Such an  $H_{110}$ -mode resonator has been designed with rectangular  $5 \times 11$  mm<sup>2</sup> waveguides for an oscillator operating in the 3-cm

wave band, based on fairly accurate engineering calculations in the one-wave approximation. The resonator was first tested with only one AA 723A Gunn-effect diode, in one of the four waveguide arms. It was then tested with three such diodes, one in each of three waveguide arms and with microwave energy extracted through the fourth arm for measurements. The resonator was tested without a dielectric insert (air-filled crossover space) and with a teflon insert (resonance frequency 8.25 GHz). The oscillator performance characteristics indicate that the output power depends on the bias voltage and peaks to a maximum of about 50 mW at a bias voltage within the 5-8 V range, the peak being much milder and the stability range correspondingly much wider with three diodes than with only one, while the operating frequency remains almost independent of the bias voltage in both cases. The data indicate also that a dielectric insert improves the performance characteristics so as to make an appreciable size reduction feasible. By changing the dielectric material, moreover, one can tune such an oscillator over a wide frequency range: to 11 GHz with air, to 8.25 GHz with teflon, to 6.25 GHz with quartz, to 5.75 GHz with glass, to 4.25 GHz with leucosapphire. Figures 2; references 7.

**Electromagnetic K-System with Long Retention of Microwave Signal Energy**

927K0152A Leningrad DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 5, Aug 91 pp 1128-1131

[Article by Ye.M. Ganapolskiy, Institute of Radio-physics and Electronics, UkSSR Academy of Sciences, Kharkov; UDC 537.86:621.37]

[Abstract] An experimental study of an electromagnetic K-system in the form of a spherical cavity surrounded by a current-conducting metal wall and containing three wave-scattering metal balls was made, considering that an electromagnetic or hypersonic wave propagating through a large cavity (diameter  $\gg$  wavelength) can behave like a material particle moving in free space. The diameter was 95 mm and the each ball was 30 mm. The surface of each ball and the inside surface of the cavity wall were silver-coated and polished. A hole had been cut through the wall for a coaxial cable holding a quarter-wave dipole antenna at the cavity entrance and connecting it to a rectangular waveguide outside. The system was tested with electromagnetic microwaves in the 8 mm radio band. The tests involved measuring the antenna input impedance over a wide frequency range and, after excitation of the cavity with a short electromagnetic pulse with a microwave content, measuring the EM-field retention time as well as the microwave-energy retention

time in the cavity. Without the scattering metal balls inside, the cavity behaved like a spherical resonator with a degenerate frequency spectrum containing several narrow resonance absorption lines. With the scattering metal balls inside, the behavior of the cavity was quite different. The discrete narrow lines had vanished from the frequency spectrum and the frequency dependence of the antenna input impedance had become smoother with only slight irregularities within a narrow range of the standing-wave ratio K. This ratio remained close to unity over a wide frequency range within the 2 GHz band), indicating a large ratio of energy stored to energy lost during one oscillation period and so despite of the high Q of the system. After a pulse of 0.1  $\mu$ s duration with a 36 GHz microwave content had been injected, the cavity retained the signal energy for more than 3  $\mu$ s at the level corresponding to a power input to power output ratio  $P_{in}/P_{out} = 10^{10}$ . The coherence (correlation) time  $T_2$ , while much longer than the oscillation period T, was much shorter than the characteristic oscillation decay time  $T_1$  so that the large bandwidth of this K-system could not possibly be attributed to some additional energy losses but rather to randomization of the electromagnetic field due to instability and mixing. One should, moreover, regard  $T_2$  as an analog of pulse or spin-spin relaxation time and  $T_1$  as an analog of energy relaxation time. Figures 3; references 3.

### Radio-Frequency Waveguide CO<sub>2</sub> Laser

927K0062A Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 54 No 6,  
Jun 91 pp 939-945

[Article by S.V. Balakin, V.G. Leontyev, V.V. Rakhvalov, V.A. Stepanov, Ye.V. Shishkanov, A.A. Yukhimuk, Plasma Scientific Production Association, Ryazan; UDC 621.378.331.8]

[Abstract] The advantages of CW waveguide CO<sub>2</sub> lasers with an RF transverse discharge, such as high gain and efficiency, low arcing voltage, etc., are outlined and the problem of reproducing and comparing the parameters of such compact lasers is addressed. To solve this problem, a sealed cermet CO<sub>2</sub> laser with water-cooled electrodes and square and rectangular waveguides with a 0.4-0.6 W/cm power density given an active medium length of 270 and 480 mm was developed and the dependence of the energy characteristics on the active medium properties and RF oscillator characteristics was examined experimentally. To this end, the dependence of the stimulated emission power on the power injected into the discharge at various active medium pressures is calculated by analyzing the kinetic processes in the gaseous discharge plasma. The measured and analytical results are adequately consistent with each other at a low excitation power and diverge somewhat at a lower power. This fact is attributed to a transition from a low-current RF discharge to a high-current discharge. The lasers' energy characteristics may be improved by decreasing optical losses in waveguide elements as well as by using efficient catalysts deposited on the electrodes, e.g., gold. The laser design is recommended for commercial production. Figures 3; tables 1; references 17: 10 Russian, 7 Western.

### Picosecond Pulse Stimulation in Binary Dye Mixture DFB Lasers With Nanosecond Excitation

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SPEKTROSKOPII in Russian Vol 54 No 6,  
Jun 91 pp 946-950

[Article by V.Yu. Kurstak, A.N. Rubinov, T.Sh. Efendiyev, Physics Institute imeni B.I. Stepanov at the Belorussian Academy of Sciences, Minsk; UDC 621.378.325]

[Abstract] Supershort pulses in a binary dye mixture develop under the conditions characterized by an excitation energy transfer from the donor to the acceptor resulting in a change in their characteristics compared to a single-component medium; furthermore, since both the gain and loss factor substantially depend on the wavelength, one can expect a significant spectral dependence of such picosecond pulse characteristics of distributed feedback (ROS) binary mixture lasers as duration, energy, polarization, and time delay of the lasing pulse development relative to the pumping pulse. To check these factors, experiments with a DFB laser excited by

TEA-N<sub>2</sub> laser pulses with a 0.7 ns duration were conducted. An ethanol solution of a mixture of coumarin dyes, coumarin-1 and coumarin-7, with a concentration of 10<sup>-2</sup> and 3x10<sup>-3</sup> mole/l, respectively, was used as the active medium of the DFB laser; the excited DFB structure was 7 mm long. The effect of radiative and nonradiative energy transfer between the active medium components on the temporal characteristics and radiation polarization of the DFB laser is established; it is also shown that the picosecond pulses are the shortest at the high-frequency end of the lasing band and increase in length with the stimulated emission wavelength. The radiation polarization degree peaks at the short-wave end of the lasing band and decreases linearly with an increase in the wavelength. Figures 5; references: 6 Western.

### Investigation of Electron Temperature Variations in Current Sheet

927K0062C Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 54 No 6,  
Jun 91 pp 1021-1024

[Article by I.L. Beygman, V.P. Gavrilenko, N.P. Kiriy, A.G. Frank, Physics Institute imeni P.N. Lebedev at the USSR Academy of Sciences, All-Union Surface and Vacuum Scientific Research Center, and General Physics Institute at the USSR Academy of Sciences, Moscow; UDC 533.951+539.186]

[Abstract] The plasma electron temperature evolution over successive stages of the current sheet existence was examined spectroscopically; in so doing, radiation bursts in spectral lines of multivalent C IV, O V, N V, and O VI ions were analyzed. The experiments were conducted in a TS-3 unit in which first a two-dimensional quasistatic magnetic field with a zero line and then plasma in this field were created with the help of three independent systems; after plasma was formed, an electric field directed along the zero line excited two-dimensional plasma currents leading the development of a planar current sheet. As electric current began passing in plasma, successive excitation of single-, double-, and triple-charged ion spectral lines was observed. After reaching the maximum intensity, the lines partially burned out; about 1.7 μs later, the glow intensity of the brightest line decreased abruptly and multiply-charged ion lines appeared. An interpretation of experimental data with the help of a hydrodynamic model shows that in the current sheets formed in transient conditions, a hot region in which the electron temperature reaches 100 eV indeed develops. The electron temperature is calculated by two methods: solving a system of ionization kinetics equations and on the basis of the spectral line intensity ratio of O VI and O V. Figures 4; table 1; references 5.